

What is claimed is:

1. A visual inspection method comprising:
taking a photograph of an illuminated
inspection target sample from above to generate
an original picture;
5 converting said original picture obtained
by said taking into a binary picture;
labeling said binary picture obtained by
said converting to generate a labeling picture;
forming a circumscribing rectangle
10 circumscribing an outer circumference of said
labeling picture obtained by said labeling;
inverting said labeling picture
circumscribed by said circumscribing rectangle
formed by said forming to generate a inversion
15 picture;
removing a picture in a region surrounded
by said outer circumference of said labeling
picture and said circumscribing rectangle from
said inversion picture obtained by said inverting
20 to generate a removal picture;
adding said removal picture obtained by
said removing to said labeling picture to
generate an inspection picture; and
judging a pass or rejection of said
25 inspection target sample based on said inspection
picture obtained by said adding.

2. The visual inspection method according to claim 1, wherein said judging is performed based on at least one of an area of said inspection picture, a diameter of said inspection picture and a circulation degree defined by a ratio of said area to another area calculated by a predetermined equation.

3. The visual inspection method according to claim 2, further comprising:

generating a new inspection picture by converting pixels around a plurality of pixels forming an outer circumference of said inspection picture into sub-pixels,

wherein said judging is performed based on said new inspection picture obtained by said generating.

4. A visual inspection method comprising:

taking a photograph of an illuminated inspection target sample from above to generate an original picture;

5 converting said original picture obtained by said taking into a binary picture;

labeling said binary picture obtained by said converting to generate a labeling picture;

calculating a summation of shade values of

10073462.02303

10 said original picture corresponding to said
labeling picture generated by said labeling; and
judging a pass or rejection of said
inspection target sample based on said summation
of the shade values obtained by said calculating.

5. The visual inspection method according to
claim 4, further comprising:

generating a new labeling picture by
converting pixels around a plurality of pixels
5 forming an outer circumference of said labeling
picture generated by said labeling into sub-
pixels,

wherein said calculating is performed by
calculating a summation of shade values of said
10 original picture corresponding to said new
labeling picture obtained by said generating.

6. The visual inspection method according to
claim 4, further comprising:

calculating an area of said labeling
picture; and

5 calculating an average shade value of said
original picture corresponding to said labeling
picture by dividing said summation of said shade
values of said original picture by said
calculated area,

10 wherein said judging is performed by
judging said pass or rejection of said inspection
target sample based on said calculated average
shade value.

7. The visual inspection method according to
claim 6, further comprising:

calculating a total average shade value by
averaging all of said calculated average shade

5 values,

wherein said judging is performed by
judging said pass or rejection of said inspection
target sample based on said calculated total
average shade value.

8. The visual inspection method according to
claim 7, wherein said judging of said pass or
rejection of said inspection target sample is
performed based on a difference between said

5 calculated average shade value and said
calculated total average shade value, or a rate
of said calculated average shade value to said
calculated total average shade value.

9. A visual inspection method comprising:

taking a photograph of an illuminated
inspection target sample from above to generate

40073158.024302

an original picture;

5 converting said original picture obtained
by said taking into a binary picture;

 labeling said binary picture obtained by
said converting to generate a labeling picture;

 calculating a distance between every two
10 pixels of a plurality of pixels forming an outer
circumference of said labeling picture over all
combinations of two pixels of said plurality of
pixels;

 determining a longest distance of a
15 plurality of said distances obtained by said
calculating; and

 judging a pass or rejection of said
inspection target sample based on said determined
longest distance.

10. The visual inspection method according to
claim 9, wherein said determining step
comprising:

 generating a first sub-pixel picture by
5 converting pixels around one of two pixels
forming said longest distance into sub-pixels and
generating a second sub-pixel picture by
converting pixels around another one of the two
pixels forming said longest distance into sub-
10 pixels;

10073158.021307

calculating a sub-pixel distance between
every sub-pixels of a plurality of sub-pixels
forming an outer circumference of said labeling
picture formed by said first sub-pixel picture
15 and every sub-pixels of a plurality of sub-pixels
forming an outer circumference of said labeling
picture formed by said second sub-pixel picture
overall combinations of a plurality of sub-pixels
forming said outer circumference of said labeling
20 picture formed by said first sub-pixel picture
and a plurality of sub-pixels forming said outer
circumference of said labeling picture formed by
said second sub-pixel picture; and

determining a longest distance of a
25 plurality of said calculated sub-pixel distances,

wherein said judging of said pass or
rejection of said inspection target sample is
performed based on said determined longest
distance of said plurality of said sub-pixel
30 distances.

11. The visual inspection method according to
claim 10, wherein said generating step further
comprising:

generating a sub-pixel picture by
5 converting pixels around one of two pixels
forming a distance in a predetermined range from

said longest distance into sub-pixels to add to
said first sub-pixel; and generating a sub-
pixel picture by converting pixels around another
10 one of said two pixels forming the distance in a
predetermined range from said longest distance
into sub-pixels to add to said second sub-pixel.

12. The visual inspection method according to
claim 9, further comprising:

generating a center or a center of gravity
of said labeling picture,

5 wherein said calculating is performed by
calculating a distance between a pixel forming an
outer circumference of said labeling picture and
being located at a farthest distance from said
center or said center of gravity calculated and
10 another pixel forming said outer circumference of
said labeling picture over all combinations of
said one pixel and said other pixel of said
plurality of pixels forming said outer
circumference of said labeling picture.

13. The visual inspection method according to
claim 9, further comprising:

converting pixels forming said labeling
picture into sub-pixels,

5 wherein said calculating is performed by

10073468-021302

calculating a distance between every two sub-pixels of a plurality of sub-pixels forming an outer circumference of said labeling picture converted into said sub-pixels over all
10 combinations of two sub-pixels of said plurality of sub-pixels.

14. The visual inspection method according to claim 3, wherein said original picture obtained by said taking is a picture of a Ball Grid Array (BGA).

15. A visual inspection apparatus comprising:
a camera which takes a photograph of an inspection target sample illuminated with an illuminator from above to output an original
5 picture;

a binary conversion unit which converts said original picture outputted from said camera into a binary picture;

a labeling unit which labels said binary
10 picture outputted from said binary conversion unit to generate a labeling picture;

a circumscribing rectangle forming unit which forms a circumscribing rectangle circumscribing an outer circumference of said
15 labeling picture generated by said labeling unit;

an inspection picture generating unit which
generates an inspection picture based on said
labeling picture surrounded by said
circumscribing rectangle formed by said
20 circumscribing rectangle forming unit; and

a judging unit which judges a pass or
rejection of said inspection target sample based
on said inspection picture generated by said
inspection picture generating unit,

25 wherein said inspection picture generating
unit comprising:

an inverting unit which inverts said
labeling picture circumscribed by said
circumscribing rectangle formed by said
30 circumscribing rectangle forming unit to generate
a inversion picture;

a removing unit which removes a picture in
a region surrounded by said outer circumference
and said circumscribing rectangle from said
35 inversion picture generated by said inverting
unit to generate a removal picture; and

an adding unit which adds said removal
picture generated by said removing unit to said
labeling picture to generate said inspection
40 picture.

16. The visual inspection apparatus according

to claim 15, wherein said judging unit judges
said pass or rejection based on at least one of
an area of said inspection picture generated by
5 said inspection picture generating unit, a
diameter of said inspection picture and a
circulation degree defined by a ratio of said
area to another area calculated by a
predetermined equation.

17. The visual inspection apparatus according
to claim 16, further comprising:

a sub-pixel generating unit which converts
pixels around a plurality of pixels forming an
5 outer circumference of said inspection picture
generated by said inspection picture generating
unit into sub-pixels to generate a new inspection
picture,

wherein said judging unit judges said pass
10 or rejection of said inspection target sample
based on said new inspection picture generated by
said sub-pixel generating unit.

18. A visual inspection apparatus comprising:

a camera which takes a photograph of an
inspection target sample illuminated with an
illuminator from above to output an original
5 picture;

a binary conversion unit which converts said original picture outputted from said camera into a binary picture;

a labeling unit which labels said binary
10 picture outputted from said binary conversion unit to generate a labeling picture;

a shade value summation calculation unit which calculates a summation of shade values of said original picture corresponding to said
15 labeling picture generated by said labeling unit; and

a judging unit which judges a pass or rejection of said inspection target sample based on said summation of the shade values calculated
20 by said shade value summation calculation unit.

19. The visual inspection apparatus according to claim 18, further comprising:

a sub-pixel generating unit which converts pixels around a plurality of pixels forming an
5 outer circumference of said labeling picture generated by said labeling unit into sub-pixels to generate a new labeling picture,

wherein said shade value summation calculation unit calculates a summation of shade
10 values of said original picture corresponding to said new labeling picture generated by said sub-

2025 RELEASE UNDER E.O. 14176

pixel generating unit.

20. The visual inspection apparatus according to claim 18, further comprising:

an area calculation unit which calculates an area of said labeling picture; and

5 an average shade value calculation unit which calculates an average shade value of said original picture corresponding to said labeling picture by dividing said summation of the shade values of said original picture calculated by
10 said shade value summation calculation unit by said area calculated by said area calculation unit,

wherein said judging unit judges said pass or rejection of said inspection target sample
15 based on said average shade value calculated by said average shade value calculation unit.

21. The visual inspection apparatus according to claim 20, further comprising:

a total average shade value calculation unit which calculates a total average shade value
5 by averaging all of said average shade values calculated by said average shade value calculation unit,

wherein said judging unit judges said pass

4474158.024300

or rejection of said inspection target sample
10 based on said total average shade value
calculated by said total average shade value
calculation unit.

22. The visual inspection apparatus according
to claim 21, wherein said judging unit judges
said pass or rejection of said inspection target
sample, based on a difference between said
5 average shade value calculated by said average
shade value calculation unit and said total
average shade value calculated by said total
average shade value calculation unit, or a rate
of said average shade value calculated by said
10 average shade value calculation unit to said
total average shade value calculated by said
total average shade value calculation unit.

23. A visual inspection apparatus comprising:
a camera which takes a photograph of an
inspection target sample illuminated with an
illuminator from above to output an original
5 picture;

a binary conversion unit which converts
said original picture outputted from said camera
into a binary picture;

a labeling unit which labels said binary

10 picture outputted from said binary conversion
unit to generate a labeling picture;

a distance calculation unit which
calculates a distance between every two pixels of
a plurality of pixels forming an outer
15 circumference of said labeling picture generated
by said labeling unit over all combinations of
two pixels of said plurality of pixels;

a longest distance calculation unit which
determines a longest distance of a plurality of
20 said distances calculated by said distance
calculation unit; and

a judging unit which judges a pass or
rejection of said inspection target sample based
on said longest distance determined by said
25 longest distance calculation unit.

24. The visual inspection apparatus according
to claim 23, further comprising:

a sub-pixel generating unit which generates
a first sub-pixel picture by converting pixels
5 around one of two pixels forming said longest
distance into sub-pixels and generates a second
sub-pixel picture by converting pixels around
another one of the two pixels forming said
longest distance into sub-pixels;

10 a sub-pixel distance calculation unit which

calculates a distance between every sub-pixels of
a plurality of sub-pixels forming an outer
circumference of said labeling picture formed by
said first sub-pixel picture generated by said
15 sub-pixel generating unit and every sub-pixels of
a plurality of sub-pixels forming an outer
circumference of said labeling picture formed by
said second sub-pixel picture generated by said
sub-pixel generating unit overall combinations of
20 a plurality of sub-pixels forming said outer
circumference of said labeling picture formed by
said first sub-pixel picture and a plurality of
sub-pixels forming said outer circumference of
said labeling picture formed by said second sub-
25 pixel picture; and

a sub-pixel longest distance calculation
unit which determines a longest distance of a
plurality of said distances calculated by said
sub-pixel distance calculation unit,

30 wherein said judging unit judges said pass
or rejection of said inspection target sample
based on said longest distance determined by said
sub-pixel longest distance calculation unit.

25. The visual inspection apparatus according
to claim 24, wherein said sub-pixel generating
unit further converts pixels around one of two

pixels forming a distance in a predetermined
5 range from said longest distance into sub-pixels
to add to said first sub-pixel picture and
converts pixels around another one of said two
pixels forming the distance in a predetermined
range from said longest distance into sub-pixels
10 to add to said second sub-pixel picture.

26. The visual inspection apparatus according
to claim 23, further comprising:

a center calculation unit which calculates
a center or a center of gravity of said labeling
5 picture,

wherein said distance calculation unit
calculates a distance between a pixel forming an
outer circumference of said labeling picture and
being located at a farthest distance from said
10 center or said center of gravity calculated by
said center calculation unit and another pixel
forming said outer circumference of said labeling
picture over all combinations of said one pixel
and said other pixel of said plurality of pixels
15 forming said outer circumference of said labeling
picture.

27. The visual inspection apparatus according
to claim 23, further comprising:

a sub-pixel conversion unit which converts
pixels forming said labeling picture into sub-
5 pixel,

wherein said distance calculation unit
calculates a distance between every two sub-
pixels of a plurality of sub-pixels forming an
outer circumference of said labeling picture
10 converted into said sub-pixels by said sub-pixel
conversion unit over all combinations of two sub-
pixels of said plurality of sub-pixels.

28. The visual inspection apparatus according
to claims 17, wherein said original picture
obtained by said camera is a picture of a Ball
Grid Array (BGA).